teristic timing. These waves are non-orthogonal in either the time or space planes, meaning that they impinge simultaneously on one or more receiving transducers, or follow paths which are substantially non-orthogonal (having a relation different than 90°).

[0055] Therefore, one embodiment of the present invention, as depicted in **FIG. 7**, is somewhat similar to the "triple transit" system, but allows acoustic signals following two different paths **1**, **2** to be received simultaneously. This system provides a first path **2** with a single reflective array **5**, which reflects acoustic waves off an opposite side **3** of the substrate **4**, back through the touch sensitive region of the substrate, back into the reflective array **5**, and to the originating transducer **6**, with a maximum path length of about two times the sum of the height plus the width. The orthogonal axis receives a portion of the same acoustic wave from the transducer **6**, which reflects off a diagonal corner reflector **7**, along a perpendicular axis has a second reflective array **8**. The wave is reflected as a set of waves **9** through the touch sensitive region of the substrate **4**, and is incident on a third reflective array **10**, which reflects the acoustic wave toward a second transducer **11** on an adjacent side of the substrate **4**, near the first transducer **6**. The maximum path length of this path is two times the sum of the height plus width. In this case, two transducers **6**, **11** receive signals simultaneously for at least some delay times.

[0056] Another embodiment of the invention provides a sensor which employs a plurality of waves having differing frequencies, wavelengths, phase velocities, or amplitude. Such waves may also be non-orthogonal in the time or space planes, but need not be so. In other words, these distinguishable waves may travel sequentially and/or over orthogonal paths.

[0057] Where portions of acoustic waves are received simultaneously by a single transducer, it is generally preferred that a receiving circuit be sensitive to a phase of a received signal in order to help resolve interference effects. Likewise, where waves of differing frequencies are employed, it is preferred that the receiver selectively receive those waves according to their frequency. Where waves of differing wave propagation mode are employed, transducer having selectivity for differing waves modes may be provided. Therefore, embodiments of the present invention may also include a receiver sensitive to at least some wave characteristics.

[0058] A further embodiment of the invention provides a positive response sensor, e.g., one where an increase in received signal is representative of a typical perturbation. Typically, a perturbation in a positive response system will cause a change of some type in the wave, making it distinguishable from an unperturbed wave. Again, such a wave may be non-orthogonal in the time or space planes, but need not be so. For example, the unperturbed signal may be completely attenuated through filtering, and therefore not received by the receiver. In this case, only a single, positive response signal according to the present invention is received.

[0059] Thus, the present invention is not limited in the conventional manner to sequential receipt of independent coherent signals representative of waves propagating along Cartesian coordinate axes, and analysis thereof to determine an attenuation of a transmitted wave by a touch by detecting the energy of the wave with respect to time. In particular, according to the present invention, a plurality of waves may be received simultaneously, the received signal may be an incoherent superposition of components from different wave sets, the waves need not propagate parallel to a rectangular coordinate axis of a planar substrate, and detection is not necessarily based solely on a determination of a time of an attenuation in power of a received signal. An improved receiver is therefore employed which includes enhanced logical analysis of the received waveform. Advantageously the waveform sensitive analysis and enhanced logical analysis may be employed together.

[0060] The receipt of at least two distinct waves which overlap temporally may indicate two waves which each have substantial energy, each being specifically intended for receipt, and potentially bearing information relating to a touch position along a coordinate axis. Alternately, one of the two distinct waves may be due to unintentionally scattered waves, artifacts and interference that are not intended for use in touch detection. In either case, a touch-information carrying signal may be utilized even if superposed with other signal components.

[0061] The present invention allows receipt and analysis of partially redundant waves. Therefore, the effects of contamination and various artifacts may be reduced. Further, where differing wave modes or frequencies are used, a differential sensing approach may be followed to determine both position and a mode sensitive characteristic of a touch.

[0062] The present invention includes a system in which the position of a touch is determined by the controller independent of the physical axes of the substrate, thus providing for coordinate processing and transformation before output. This allows increased flexibility in the layout of the transducer systems. In this document, "transducer system" is defined to be the system that couples electronic signals to acoustic waves in the desired touch region including the transducer itself, e.g. a wedge or edge transducer, and associated reflective arrays if employed.

[0063] The present invention also allows receipt and analysis of signals which are excited by a common transducer representative of differing sets of wave paths with overlapping characteristic time-periods.

[0064] A still further aspect of the invention provides an acoustic wave touch sensor in which a touch is detected by a perturbation of a received signal where the perturbation may be a decrease in amplitude, an increase in amplitude, a change in phase of the received signal, or a combination of amplitude change and phase change.

[0065] One set of embodiments according to the present invention includes systems employing multiple waves sharing a common path portion. The known triple transit transducer also shares common path portions, but does not have simultaneously received waves or a transformation of coordinate system. In other words, the known triple transit system requires a time separation between received waves representing orthogonal axes, thus limiting the topology of the sensor.

[0066] According to one aspect of the present invention, a plurality of waves traveling along non-orthogonal axes in the active region of the touchsensor may have common path portions, being at least partially superposed. In particular,